EXECUTIVE SUMMARY

The primary purpose of this office report is to identify potential ecosystem restoration opportunities that address the planning objectives of the Shasta Lake Water Resources Investigation (SLWRI) and should be considered further in future feasibility scope studies. This report highlights: existing environmental conditions and problems, ongoing conservation and environmental restoration programs in the study area, potential ecosystem restoration opportunities, and potential ecosystem restoration plan components for consideration in future planning efforts.

BACKGROUND

In 2000, the U.S. Department of the Interior, Bureau of Reclamation, Mid-Pacific Region (Reclamation) reinitiated a feasibility investigation to evaluate the potential for enlarging Shasta Dam for increased water supply and operational flexibility. Increases in demands for water supplies and attention to ecosystem needs in the Central Valley of California have renewed interests on expanding the facility. The SLWRI is being conducted under the general authority of Public Law 96-375 (1980). A Mission Statement Milestone Report for the study was completed in March 2003 to guide project planning efforts; it outlines the resource problems, study objectives, and mission statement for the SLWRI.

Study Area

The primary study area includes Shasta Lake and vicinity; the lower reaches of rivers and streams tributary to Shasta Lake, including the Sacramento, McCloud, and Pit rivers; and the Sacramento River downstream from Shasta Dam to about the Red Bluff Diversion Dam. Discussions in this office report are separated into two geographic sub-areas: the Shasta Lake and Tributaries sub-area, and the Sacramento River from Shasta Dam to Red Bluff sub-area.

Plan Formulation Process

Formulation of alternative plans for the SLWRI, including ecosystem restoration components, is guided by the study objectives and mission statement developed in the Mission Statement Milestone Report. There are two primary study objectives, and three secondary study objectives. The primary objectives are:

- Increase the survival of anadromous fish populations in the Sacramento River primarily upstream from the Red Bluff Diversion Dam.

- Increase water supplies and water supply reliability for agricultural, M&I, and environmental purposes to help meet future water demands, with a primary focus on enlarging Shasta Dam and Reservoir.

The secondary objectives represent features that are to be included, to the extent possible, through the pursuit of the primary objectives:

- Preserve and restore ecosystem resources in the Shasta Lake area and along the upper Sacramento River.

- Reduce flood damages along the Sacramento River.

- Develop additional hydropower capabilities at Shasta Dam.

The ecosystem restoration measures developed herein address the primary objective to increase the survival of anadromous fish populations and/or the secondary objective to preserve and restore ecosystem resources in the Shasta Lake area and along the upper Sacramento River.

The mission statement developed for the SLWRI is as follows:

> *To develop an implementable plan primarily involving the enlargement of Shasta Dam and Reservoir to promote increased survival of anadromous fish populations in the upper Sacramento River; increased water supply reliability; and to the extent possible through meeting these objectives, include features to benefit other identified ecosystem, flood control, and related water resources needs.*

ENVIRONMENTAL PROBLEMS

The study area has experienced a general decrease in the quantity and quality of native habitat, and a subsequent decrease in the population of many individual plant and animal species. This has resulted in a growing number of threatened and endangered species inhabiting the region. Key environmental problems identified in the two study sub-areas are include:

Shasta Lake and Tributaries Sub-Area

- Reductions in warm-water and cold-water fisheries in Shasta Lake, resulting primarily from (1) acid mine drainage, (2) lack of shallow-water, shoreline habitat, and (3) human disturbances.
- Reductions in fisheries in the tributaries to Shasta Lake, resulting primarily from (1) modification of seasonal flows, (2) loss of access to historic spawning and rearing areas, and (3) acid mine drainage.
- Reductions in riparian and wetland habitat in the sub-area, resulting primarily from increased erosion and sediment input, and non-native species.

Shasta Dam to Red Bluff Sub-Area

- Reductions in anadromous fish in the upper Sacramento River, primarily resulting from (1) water temperature, (2) physical migration barriers, (3) diversions and flow regulation, (4) reduction in suitable spawning gravels, (5) acid mine drainage, and (6) unnatural predation rates.

- Reductions in riparian, floodplain, and wetland habitat in the Shasta Dam to Red Bluff sub-area, primarily resulting from (1) changes to natural geomorphic processes, (2) urban and agricultural encroachment, and other land management changes, and (3) invasive species.

RELATED RESTORATION AND CONSERVATION PROGRAMS

Various Federal and State agencies, local working groups, and private organizations are active in environmental restoration and conservation in the study area. Several of the programs that were influential in identifying restoration opportunities are highlighted below.

- **Central Valley Project Improvement Act (CVPIA), 1992 –** The CVPIA amended the authority of Reclamation's Central Valley Project and included a directive to develop and implement actions to promote the recovery of anadromous fish in Central Valley streams. Numerous actions to improve the natural production of anadromous fish have been recommended and/or funded by the Anadromous Fish Restoration Program through the CVPIA, including various completed and ongoing projects in the study area.

- **CALFED Bay-Delta Program (CALFED) –** CALFED is a cooperative effort among State and Federal agencies and California's environmental, urban and agricultural communities to address environmental and water supply problems associated with the Bay-Delta system. One of CALFED's programmatic elements, the Ecosystem Restoration Plan (ERP), identifies and recommends restoration actions in several ecological management zones, two of which fall within the SLWRI study area. In the North Sacramento Valley Ecological Management Zone, the ERP recommends actions on Clear, Cow, Bear, and Battle creeks; CALFED has helped to fund several of these restoration efforts. In the Cottonwood Creek Ecological Management Zone, recognized as the primary source of coarse sediments and spawning gravel for the Sacramento River, recommendations include flow augmentation, instream habitat restoration, revegetation, and other actions to preserve and restore the watershed.

- **Sacramento River Conservation Area Program –** Established by California Senate Bill 1086, the Sacramento River Conservation Area Program has an overall goal of preserving remaining riparian habitat and reestablishing a continuous riparian ecosystem along the Sacramento River between Redding and Chico. Specific actions recommended by the program in the SLWRI study area include: spawning gravel replenishment; development of side-channel spawning areas; elimination of short-term flow fluctuations; maintaining instream flows through coordinated operation of water facilities; acid mine drainage reduction; and various fisheries improvements on Clear, Battle, and Cottonwood creeks.

Resource conservation districts, coordinated resource management groups, and various private organizations in the region have also produced studies and implemented programs related to fisheries and habitat restoration that were useful in identifying environmental problems and opportunities in the study area.

ECOSYSTEM RESTORATION OPPORTUNITIES

Over 40 preliminary ecosystem restoration measures were identified to address the primary and secondary study objectives, based on the environmental problems and needs and the recommendations of other ongoing restoration programs. The preliminary measures were compared and screened based on the following criteria: (1) ability to fulfill one or more of the study objectives, (2) relative likelihood of physical implementation, (3) ability to provide consistent and reliable benefits, (4) the degree of future actions required to achieve or maintain benefits, (5) potential to negatively impact an existing beneficial use or create significant mitigation obstacles, and (6) efficiency based on relative cost and accomplishments. Of the ecosystem restoration measures identified, nine were selected that are believed to warrant further consideration for possible consideration in future formulation of multi-purpose alternatives for the SLWRI. These preliminary ecosystem restoration components are summarized in Table ES-1. Upon further evaluation, six of the measures were given high recommendations.

CONCLUSIONS

Although numerous public and private groups are actively pursuing ecosystem restoration in the upper Sacramento River area, there remains significant opportunities to implement actions to help restore ecosystem values in the study area, consistent with the goals and objectives of the SLWRI. It is believed that future plan formulation efforts for the SLWRI should include consideration of the nine identified ecosystem restoration measures, with emphasis placed on the six highly recommended measures. Although additional study and refinement are required, each of the highly recommended measures are believed to be (1) capable of significantly contributing to the study objectives, (2) consistent with the goals and objectives of CALFED and other Sacramento River management programs, and (3) capable of support from a non-federal sponsor.

TABLE ES-1
PRELIMINARY ECOSYSTEM RESTORATION PLAN COMPONENTS

ID No.	Measure Description	First Cost[1] / Annual Cost[2]	Benefits / Advantages	Implementation Issues / Disadvantages	Comments and Conclusions
A1	**Construct Shoreline Fish Habitat around Shasta Lake** *20 acres of shallow-water habitat restoration around Shasta Lake.*	$1.6 million Moderate – High	Improve shallow, warm-water fish habitat in drawdown area; improve juvenile rearing; increase angling opportunities.	May create submerged hazards for watercraft; likely high operation and maintenance, as structures would need to be replaced periodically.	▪ **High recommendation** ▪ Good potential to combine with other measures ▪ Moderate uncertainty
A5	**Construct Instream Fish Habitat on Tributaries to Shasta Lake** *8 miles aquatic habitat restoration along lower reaches of perennial tributaries to Shasta Lake.*	$0.6 million Moderate – High	Improved spawning and rearing habitat in Shasta tributaries.	Habitat structures would need to be replaced periodically; site access may be problematic.	▪ **High recommendation** ▪ Good potential to combine with other measures ▪ Low uncertainty
A7	**Restore Inactive Gravel Mines on Sacramento River** *Restoration of 150 acres of land formerly mined for gravel.*	$8 million Moderate	Provides benefits for both aquatic and floodplain habitats; reduced mortality at pits and improved spawning success.	Land acquisition would be required to ensure long-term benefits.	▪ **High recommendation** ▪ Good potential to combine with other measures ▪ Benefits both terrestrial and aquatic habitats ▪ Low uncertainty
A8	**Construct Instream Habitat Downstream from Keswick Dam** *¾ mile of aquatic habitat restoration on the Sacramento River downstream from Keswick Dam.*	$0.8 million Moderate – High	Improved spawning success in a reach currently unsuitable for spawning; reduced mortality below dam.	Design and construction constraints related to site conditions and dam releases; high operation and maintenance, as habitat structures would need to be replaced periodically; low potential for inclusion in Federal projects.	▪ High long-term cost for restoring a relatively small, although strategically located, reach of river ▪ Moderate uncertainty ▪ Potential for non-federal consideration
A9	**Replenish Spawning Gravel in Sacramento River** *10,000 tons spawning gravel injected at three sites between Keswick Dam and Red Bluff.*	$0.4 million Very High	Improved aquatic habitat / spawning success; gravel may become limiting factor in fisheries restoration; benefits would continue as gravel moves through system.	Very high operation and maintenance, as gravel injections would need to be repeated at frequent intervals to maintain benefits over project life; concerns over downstream impacts to infrastructure; low potential for inclusion in Federal projects.	▪ Very low initial cost but higher long-term cost ▪ Moderate uncertainty ▪ Potential for non-federal consideration

TABLE ES-1 (CONT.)
PRELIMINARY ECOSYSTEM RESTORATION PLAN COMPONENTS

ID No.	Measure Description	First Cost[1] / Annual Cost[2]	Benefits / Advantages	Implementation Issues / Disadvantages	Comments and Conclusions
A10	**Additional Modifications to Shasta Dam for Temperature Control** *Expansion of existing temperature control device at Shasta Dam.*	Similar to existing TCD Low	Improved temperature control would support spawning success.	Potential for high initial cost depending on other modifications to Shasta Dam.	▪ **High Recommendation** ▪ High potential to combine with other measures ▪ Moderate uncertainty
A12	**Enlarge Shasta Lake Cold Water Pool** *Raise Shasta Dam between about 6.5 and 18 feet and enlarge Shasta Reservoir by between 290,000 and 630,000 acre-feet, respectively.*	$210 to $290 million Low	Increased cold water release capability from Shasta Dam would improve meeting downstream water temperature goals and spawning and rearing success and likely water supply reliability, hydropower, and lake area recreation benefits.	High initial costs; adverse impacts to reservoir rim physical and natural resources requiring significant mitigation measures.	▪ **High recommendation** ▪ Consistent with CALFED ▪ High initial costs ▪ Strong potential to combine with other measures ▪ Low uncertainty
A13	**Modify Storage and Release Operations at Shasta Dam** *Reoperate Shasta Dam to benefit anadromous fisheries.*	Low (without mitigation) Low	Greater flexibility in meeting fishery needs would improve spawning and rearing success.	Would only be feasible with measures to mitigate likely adverse impacts to water supply reliability and other resources.	▪ **High recommendation** ▪ Good potential to combine with other measures ▪ Moderate uncertainty
B10	**Riparian and Floodplain Restoration along Sacramento River** *500 acres of floodplain and riparian habitat restoration near tributary confluences.*	$9 million Moderate – High	Restores floodplain and riparian habitat, with residual benefits to aquatic habitat (source of shade and woody debris); restore natural processes.	Land acquisition would be required to ensure long-term benefits.	▪ Good potential to combine with other measures ▪ Benefits both terrestrial and aquatic habitats ▪ Low uncertainty

Notes:
1. *First Cost includes initial construction, real estate, planning, engineering, and design; represents the initial cost required to implement the measure.*
2. *Relative comparison to first cost. Annual Cost includes annual monitoring, operation, and maintenance costs, and any periodic or recurring costs associated with the measure.*